

BACKGROUND OF THE INVENTION AND RELATED ART

This application claims the priority of U.S. Provisional Patent Application No. 60/456,578, filed March 24, 2003, the disclosure of which is incorporated by reference herein.

The present invention relates to wetness indicators and, more particularly, to indicator composites incorporating pH indicating agents and to compositions that may be used to make such indicator composites. The indicators may be of a single layer or multiple layer composite, and they may be incorporated in articles and devices wherein it is desirable to sense pH, moisture or wetness.

Chemical compounds that change color with change in pH are well-known in the art. The use of such compounds, or so-called pH indicating agents, to provide pH and wetness indications is also known.

Such wetness indicators are frequently used in connection with disposable diapers. For example, U.S. Patent 3,675,654 includes a translucent backing sheet and an indicating agent applied to an absorbent pad surface adjacent the backing sheet which becomes visible upon moisture contact. U.S. Patent 3,731,685 utilizes capillary action to transmit interior diaper moisture along a strip to an exterior end of the strip having an indicator agent. The pH indicating agent is incorporated in a latex adhesive applied to the backing sheet or adjacent pad surface of a disposable diaper in U.S. Patent 4,231,370. It is also known to incorporate indicating agents in hot melt adhesives used in diapers as disclosed in U.S. Patents 4,743,238, 5,035,691, 5,066,711 and 5,089,548. In U.S. Patent 5,354,289, such

1 a hot melt adhesive strip is isolated from the diaper
2 interior by a water impervious baffle that extends beyond
3 the adhesive strip dimensions to cause liquid to flow
4 around the edges of the baffle in order to contact the
5 indicator agent and thereby provide a capacity monitor.

6 Wetness indicators not using pH indicating agents
7 are also used in disposable diaper constructions to
8 provide visible indicia of diaper wetness. These include
9 water soluble dyes rendered visible by contact with
10 diaper liquid in U.S. Patent 3,675,654. An the opposite
11 approach is used in U.S. Patent 4,022,211 wherein the
12 indicia is visible if dry, but dispersed upon diaper
13 wetting. In other approaches, visibility masks are
14 removed by diaper wetting to allow viewing of the wetness
15 indicia as in U.S. Patents 4,192,311 and 4,705,513.

16 As distinguished from wetness indicators not using
17 pH indicating agents, the present invention contemplates
18 the use of a pH indicating agent for pH or wetness
19 indication of an environment. Herein, an environment
20 comprises a moisture containing fluid. The fluid may be
21 present in liquid and/or in condensable vapor form.

22 SUMMARY OF THE INVENTION

23 It has now been discovered that pH indicating agents
24 may be utilized more effectively with fluid regulation or
25 control in single layer and multiple layer wetness
26 indicators within a desired timeframe of use. Fluid
27 control may be used to promote or to inhibit fluid
28 contact with the pH indicating agent as well as to limit
29 the diffusion of the latter.

30 As used herein, fluid regulation includes one or
31 more of the following. (i) Moisture transmission or
32 absorption enabling controlling or regulating the amount

1 of fluid contacting the surface or flowing into the body
2 of one or more layers of the indicator. (ii) Obstructing
3 or preventing the bleed of indicator back into the
4 environment. In preferred embodiments, fluid regulation
5 includes both moisture transmission and bleed prevention.

6 The invention contemplates a controlled pathway for
7 fluid which comprises moisture and/or other pH
8 contributing species such as acids or alkali ions in a
9 water phase to be transported to the surface of the
10 indicating layer or into its body for indication. The
11 extent of transport of fluid is regulated to be
12 representative of the extent of wetness in the
13 environment or to its pH level. A pathway for indicating
14 agent back into the environment may also result as a
15 consequence of creating this pathway for moisture into
16 the indicator body. A preferred embodiment would be the
17 use of barrier layers or fluid regulating additives that
18 are moisture absorbing or transmitting resins, which
19 allow for transmitting moisture in one direction but also
20 prevent bleed in the reverse direction within the
21 contemplated fluid regulation herein.

22 In the illustrated embodiments, fluid regulation is
23 provided through at least a portion of the thickness of a
24 layer of the wetness indicator in order to contact the pH
25 indicating agent. Also illustrated is an ink for
26 constructing such layers with said transmission.
27 Typically, the wetness indicator has a surface exposed to
28 the fluid and at least a portion of the wetness
29 indicating agent is contained within a layer for contact
30 with the fluid following transmission of the fluid
31 through the layer.

32 The fluid regulating additive, or at least a portion
33 thereof, may be incorporated in one or more layers of the

1 wetness indicator to enable control of the fluid
2 contacting the pH indicator. To that end, the layer
3 containing the pH indicator may have sufficient
4 microporosity and/or moisture vapor transmission rate
5 (MVTR) to achieve fluid penetration to contact the pH
6 indicator or a moisture transmitting additive may be
7 incorporated in at least the portion of the thickness of
8 the layer to achieve fluid contact with the pH indicating
9 agent therein.

10 Suitable pH indicating agents are well known in the
11 art and include cresol red, thymol blue, methyl yellow,
12 methyl orange, bromophenol blue, bromocresol green,
13 methyl red, p-Nitrophenol, phenol red, phenolphthalein and
14 Alizarin yellow R. These agents are commercially
15 available from numerous suppliers such as Neha Chemicals.

16 Suitable fluid regulating additives include
17 commercially available superabsorbent polymers, typically
18 polyacrylates, available from Dow Chemical, BASF (HYSORB
19 brand), Degussa AG (FAVOR brand). Cellulose and
20 cellulosic derived resins, such as ETHOCEL brand from Dow
21 Chemical, may also be used as additives. Anhydride
22 resins such as maleic anhydride or nadic methyl anhydride
23 or SMA brand resins from Sartomer Company are also
24 useful. Polyolefin blended resins, such as INTERACT 91-
25 04365 available from ONeil Color, suitable for blending
26 with other plastics during extrusion, may be used.
27 Synthetic zeolites such as Zeolum Series by Tosoh may be
28 used. Zeolites with controlled pore size openings have
29 an added benefit of acting as barriers that allow the
30 forward flow of moisture due to the smaller molecular
31 size of water into the indicator while obstructing the
32 reverse flow of pH indicating agents (larger molecular
33 size) back into the environment. Other suitable

1 additives may comprise typical desiccants such as silica
2 gel, calcium oxide, clays and calcium sulfate may be
3 used.

4 As noted above, preferred embodiments of the
5 invention contemplate fluid regulation including fluid
6 transmission to the pH indicating agent and inhibiting of
7 bleed of the agent into the fluid. Zeolites with
8 selected pore opening sizes allow for both mechanisms.
9 Dispersions of fine hollow cellulose fibers in the layer
10 would also accomplish both mechanisms by transmitting
11 moisture due to their absorbent nature or by providing
12 means to entrap the indicating agent.

13 The wetness indicator may comprise a single layer
14 wherein both pH indication and fluid control occur. For
15 example, in the illustrated embodiments, a single layer
16 may be provided with a microporosity or moisture vapor
17 transmission rate sufficient to enable fluid penetration
18 and contact with pH indicating agent disposed within at
19 least a portion of the thickness of the layer.

20 The wetness indicator may comprise a multiple layer
21 composite wherein pH indication and fluid control occur
22 in separate layers, or in both layers. In the
23 illustrated embodiments, the layer providing fluid
24 control is disposed between the environment and the layer
25 containing the pH indicating agent.

26 In accordance with the invention, a layer may
27 comprise or be in the form of a polymer layer, an ink or
28 coating layer, or a fibrous layer or mixtures thereof.
29 The layer may be continuous or discontinuous. A
30 composite may include similar or different types of
31 layers. Further, a composite may include a matrix which
32 is a structure that allows for a dispersed phase.

1 The polymer layer may be a substantially continuous
2 film of polymer that is impermeable to the fluid.
3 Alternatively, the polymer layer may have a microporosity
4 or a sufficient MVTR, in at least a portion of its
5 thickness, to permit full or partial penetration by the
6 fluid of the environment. The polymer layer may comprise
7 polyolefin based polymers such as polypropylene, films,
8 polyethylene films or other polymers such as polyester,
9 polystyrene, polyvinyl chloride or polyurethane films or
10 composites thereof. Films formed of copolymers, polymer
11 blends and mixtures thereof are also contemplated. An
12 example of a film described above could be biaxially
13 oriented polypropylene film.

14 Suitable porosities defined in terms of pore opening
15 size are 1 micron to 150 microns pore size and useful
16 MVTR range from 0.5 g/100 sqin/24hr to 25,000 g/100, and
17 more preferably, from 1,500 to 15,000, and most
18 preferably, from 2,500 to 8,000 sqin/24hr as measured by
19 ASTM E98.

20 In flexible indicator applications, useful polymer
21 layers may have a weight as low as 2 grams/meter² (gsm)
22 and up to about 105 gsm and, more preferably, in the
23 range of from 6 to 45 gsm. The thickness of the polymer
24 layer may range from a fraction of a mil up to about 6
25 mils.

26 The desired fluid penetration of the polymer layer
27 may be provided by a moisture transmitting additive
28 dispersed in at least a portion of the polymer. The
29 moisture transmission rate may be selected in accordance
30 with a particular application. Useful transmission rates
31 are 0.5 g/100 sqin/24hr to 25,000 g/100 sqin/24hr.

32 In the illustrated embodiments, the moisture
33 transmitting additive comprises a fluid regulating
34 additive as noted above. The fluid regulating additives
35 may be dispersed throughout the layer thickness or in

1 selected portions of the layer. The additive may be used
2 in amounts ranging from 1% to 35% based on the weight of
3 the layer components, and more preferably, with better
4 performance in the 5% to 25% range, and most preferably,
5 in the 5% to 15% range, depending upon the application.

6 The moisture transmission or MVTR increases with
7 increasing additive concentration and results in
8 decreased or shorter time for indication by the pH
9 indicating agent. Conversely, the lower the
10 concentration of moisture transmission additive, the
11 lower the moisture transmission or MVTR and the greater
12 the time for indication or response. For example, a
13 single layer composite containing 25% fluid regulating
14 additive and 4% pH indicating agent, when contacted with
15 liquid water may commence substantial indication in less
16 than 30 seconds. The same composite with reduced
17 additive of 10% and 4% indicating agent may require over
18 50 seconds to substantial indication. In both cases, the
19 composites were exposed to 5cc of water.

20 The pH indicating agent may also be dispersed
21 throughout the layer thickness or in selected portions of
22 the layer and/or applied to a surface thereof. The pH
23 indicating agent may be used in amounts ranging from 0.1
24 to 25% based on the weight of the polymer layer.

25 The ink or coating layer may be formed of polymers,
26 fibers and/or resins, and may therefore differ from a
27 polymer layer in some applications. For convenience
28 herein, reference to an ink layer will be understood to
29 include a coating unless otherwise prohibited by the
30 context. As in the case of a polymer layer, the ink
31 layer may be impermeable to the fluid or permeability may
32 be achieved by microporosity or a fluid regulating
33 additive contained in the ink layer. Layers printed with

1 such inks could be substantially continuous or
2 discontinuous in the form of separated dots as is common
3 with current process print technology.

4 For flexible indicators, the ink layer may range in
5 weight from 1 to 7 gsm, and have a thickness as low as
6 0.05 mil to as high as 1 mil. Also, the pH indicating
7 agent may be dispersed in the ink layer thickness in a
8 range of from 0.1 to 25% based on the weight of the ink
9 layer.

10 The fibrous layer may be a paper, a woven or a
11 nonwoven fabric layer that is formed of natural or
12 synthetic fibers, or combinations thereof. Synthetic
13 fibers may have a continuous cross-section or a hollow
14 cross-section. Coaxial or composite fibers comprising
15 concentric layers of different polymers may also be used.
16 The fabric layer may be substantially impermeable to the
17 fluid of the environment, and fluid flow may be provided
18 by applying to the exterior fiber surfaces an ink layer
19 having the desired fluid permeability. In the case of
20 coaxial fibers, the fluid regulating additive may be
21 incorporated in at least one of the concentric polymer
22 layers forming the fiber.

23 Another embodiment of this invention is a pH
24 indicating ink that allows for moisture transmission.
25 The inks could be formulated as solvent based, water
26 based or UV or other radiation curable inks. Water based
27 inks are generally not preferred especially if the
28 purpose of the ink is to indicate the presence of
29 moisture. The indicating agent would be activated by the
30 liquid ink and proper functionality would be dependent on
31 drying the ink completely so that little or no indicating
32 agent would remain activated. Suitable inks would

1 comprise a pH indicating agent and a fluid regulating
2 additive.

3 BRIEF DESCRIPTION OF THE DRAWINGS

4 FIG. 1 is a sectional view of a single layer wetness
5 indicator in accordance with the invention;

6 FIG. 2 is a sectional view of a multiple layer
7 wetness indicator in accordance with the invention;

8 FIG. 3 is a sectional view of a multiple layer
9 wetness indicator in accordance with another embodiment
10 of the invention;

11 FIG. 4 is an elevational view, partly in section,
12 showing a hollow fiber wetness indicator in accordance
13 with the invention;

14 FIG. 5 is an elevational view, partly in section,
15 showing a coaxial fiber wetness indicator in accordance
16 with the invention;

17 FIG. 6 is a sectional view of a multiple layer
18 wetness indicator in accordance with another embodiment
19 of the invention;

20 FIG. 7 is a sectional view of a multiple layer
21 wetness indicator in accordance with another embodiment
22 of the invention;

23 FIG. 8 is a sectional view of a multiple layer
24 wetness indicator in accordance with another embodiment
25 of the invention;

26 FIG. 9 is a perspective view showing a disposable
27 diaper having the wetness indicator arranged therein to
28 indicate diaper wetness; and

29 FIG. 9A is a fragmentary perspective view, on an
30 enlarged scale, showing the wetness indicator
31 incorporated in the disposable diaper of FIG. 9.

DETAILED DESCRIPTION OF THE DRAWINGS

Referring to FIG. 1, a single layer wetness indicator 10 is provided by a microporous polymer layer 12 containing dispersed pH indicating agent 14. For example, a polypropylene film having adequate fluid diffusion properties may be blended with Thymol Blue as the pH indicating agent. In this manner, the polypropylene provides a polymer matrix having the indicating agent dispersed therein.

The indicator 10 is disposed adjacent a transparent wall portion 16 of a food packaging container (not shown). For example, the food container may be a flexible bag container for potato chips, and the indicator 10 would indicate staleness or an undesirable level of moisture within the container. The indicator 10 may be mounted to the wall portion 16 by a translucent or transparent adhesive, or it may be otherwise retained adjacent wall portion 16 with all surfaces thereof exposed to the environment.

In this instance, the sensed environment comprises fluid within the interior of the container and excessive levels of moisture are identified by the indicator 10. In such an application, it may be preferred to use an indicator having a high MVTR range since diffusional resistance to flow of moisture vapor into the indicator should be minimized.

The incorporation of pH indicating agent into the thickness of the layer with fluid penetration to reach the agent provides several advantages in accordance with the invention. In the absence of fluid penetration, the prior art incorporation of pH indicating agent into the thickness of the layer results in a substantial portion of the agent being isolated from contact with the fluid

1 and therefore rendered ineffective. Accordingly, fluid
2 penetration in accordance with the invention enables a
3 reduced amount of pH indicating agent to be used and a
4 reduced amount of bleed of the agent into the environment
5 while achieving a similar response level as compared with
6 the prior art.

7 Further, the use of a fluid barrier layer or
8 moisture transmitting resins such as ZEOLUM reduce the
9 bleed of indicator into the environment by providing
10 hindrance to the migration of the agent. While steric
11 hindrance is inherent to any polymer mixture, these
12 embodiments are particularly effective in reducing bleed.
13 The barrier layer could function as an external wall of
14 obstruction, the thickness of which would increase the
15 resistance to migration of the agent whereas the use of
16 zeolite resins or resins containing hollow fibers provide
17 a means to entrap the indicating agent thereby minimizing
18 its bleed into the environment. These embodiments are
19 particularly useful in allowing formulators more freedom
20 in choosing components for wetness indicating layers.
21 These embodiments are also useful in helping preserve the
22 definition of graphics that are comprised of such
23 composites.

24 Referring to Fig. 2, a multiple layer wetness
25 indicator 18 comprises multiple layer composites formed
26 by a pH indicating layer 20 and a fluid barrier layer 22.
27 An indicating agent 24 is dispersed in the layer 20 and,
28 for example, this layer and indicating agent may be the
29 same as in the layer 14 of the embodiment of FIG. 1.

30 The fluid barrier layer 22 contains a fluid
31 regulating additive 26 dispersed therein to provide the
32 desired degree of moisture transmission. For example,
33 the layer 22 may be formed on polyethylene and the fluid

1 regulating additive 26 may comprise superabsorbent
2 polymer dispersed in a polypropylene matrix. The
3 relative amount of fluid regulating additive 26 may be
4 selected in accordance with the concentration or level of
5 fluid present in the environment and whether the fluid is
6 present in a relatively high diffusible liquid species or
7 a relatively low diffusible vapor species. Also,
8 increased amounts of fluid regulating additive will
9 result in increased fluid transmission and affect the
10 desired response time. Accordingly, specific
11 concentrations of fluid regulating additive will depend
12 upon the application.

13 Referring to FIG. 3, a wetness indicator 28
14 comprises a multiple layer composite of a pH indicating
15 layer 30 and a fluid barrier layer 32. The layer 32 may
16 be formed of the same polymer as layer 24 described
17 above. In this embodiment, the layer 32 has a
18 microporosity sufficient to transfer fluid from the
19 environment through its thickness for contact with the pH
20 indicating layer 30. Accordingly, it is not necessary to
21 add a separate fluid regulating additive. Of course, a
22 polymer of lesser microporosity may have a fluid
23 regulating additive added to it.

24 It should be appreciated that each of the wetness
25 indicators described above may be provided in the form of
26 a polymer layer, a printed ink layer or a fibrous layer.
27 Further, the microporosity of the layers enables the
28 fluid or moisture to penetrate deeper into the layer or
29 layers, based upon the amount of fluid present in the
30 environment. Accordingly, multiple layers may each have
31 a different pH indicating agent and response or different
32 concentration and intensity of response. In this manner,
33 the layers may be arranged to provide for indication of

1 threshold levels and/or different degrees of wetness or
2 fluid in the environment.

3 Referring to Fig. 4, a wetness indicator 34
4 comprises a hollow fiber 36 including an annular or
5 cylindrical layer 38 and a central passage 40. The
6 cylindrical layer 38 may be formed of a polymer having a
7 sufficient microporosity or MVTR to provide a fluid
8 barrier layer function as described above. An ink layer
9 or coating 42 containing a pH indicating agent (not
10 shown) is applied to the exterior surface of the layer
11 38. As in prior embodiments, the pH indicating agent may
12 be dispersed throughout the thickness of the ink layer or
13 coating 40.

14 In this embodiment, a wetness indicator 34 may
15 comprise a plurality of fibers 36 as described above that
16 are arranged to contain the environment within the
17 central passages 40. In practice, the environment may be
18 caused to flow through the passages 40 and the level of
19 fluid contained within the environment may be monitored.

20 Referring to FIG. 5, a wetness indicator 44
21 comprises a coaxial or composite fiber 46. The coaxial
22 fiber 46 includes an inner layer or central core 48
23 formed of a first polymer that contains a pH indicating
24 agent. The fiber 46 also has an outer annular layer 50
25 formed of a second polymer, which may be the same or
26 different from the first polymer, and has sufficient
27 microporosity or MVTR to function as a fluid barrier
28 layer. For example, the layers 48 and 50 may each be
29 formed of polypropylene, or one of the layers may be
30 formed a polyethylene.

31 In practice, a wetness indicator 52, as shown in
32 FIG. 6, may comprise a plurality of fibers 46 arranged as
33 a woven fabric 52a or a nonwoven fabric 52b. Each layer

1 52a and 52b may contain fibers 46 of similar layer
2 barrier and indicating functions. Of course, the woven
3 fabric 52a and the nonwoven fabric 52b may be used
4 separately to provide wetness indicators.

5 Referring to FIG. 7, a wetness indicator 60
6 comprises a multiple layer composite formed by layers 62,
7 64, 66 and 68. Each of the layers 62, 64 and 66 may
8 include differing amounts of pH indicating agents or
9 different pH indicating agents. In addition, each of the
10 layers 62, 64 and 66 provides sufficient microporosity or
11 MVTR to allow penetration by the fluid of the environment
12 and contact with the pH indicating agents. The degree of
13 fluid penetration will be proportional to the fluid
14 concentration or level in the environment. The layer 68
15 is a clear or transparent layer.

16 Further, the wetness indicator 60 may be arranged so
17 that, depending on the side of view A or B, the layers
18 62, 64 and 66 could become opaque, transparent, change
19 color, or expose or hide graphics as indicators for the
20 degree of wetness.

21 Referring to FIG. 8, a wetness indicator 70
22 comprises a three layer composite including a protective
23 layer 72, an indication layer 74 and a barrier and
24 anchorage layer 76. The indication layer 74 comprises a
25 layer of pH indicating printing ink. The layer 76
26 secures the composite 70 to a substrate 78. In this
27 composite, the barrier layer 72 prevents the indicating
28 agent dye from flowing or dissipating into the
29 surrounding fluid environment, but does allow for the
30 passage of fluid to the indication layer. Such a layer
31 may consist of any ink that is somewhat transparent to
32 allow for visual indication in viewing from side A. Such
33 an ink layer may also consist of polymers and/or resins

1 that allow for absorption, transmission of moisture and
2 fluid to allow the indicating layer to come into fluid
3 contact and be activated. The degree of saturation or
4 penetration of fluid in this layer enables differential
5 indication. The layer 76 may be present as a barrier
6 anchorage layer that is applied to the substrate 78 prior
7 to applying the indicating layer 74. The function of the
8 layer 76 may include allowing for visual indication from
9 side B, assisting in anchoring the layer 74 to the
10 substrate 78 and further sealing the adjacent side of the
11 indication layer 74 so that activation can only occur
12 from one side.

13 Referring to FIG. 9, a disposable diaper 80 is
14 shown. The diaper 80 includes a water impervious backing
15 sheet 82 and absorbent pad 84 which may include an
16 absorbent fiber layer as well as a facing sheet which
17 would contact a user's skin. The composite 70 is secured
18 to the inside surface of the backing sheet 82 by the
19 barrier anchorage layer 76. The layer 76 is
20 substantially transparent so that indication layer 74,
21 upon contact with the urine or fluid environment of the
22 diaper, will be visible through the backing sheet 82.

23 The barrier layer 72 also prevents premature
24 activation of the pH indicating agent due to moisture
25 present in the diaper during storage and prior to use.
26 Thus, the microporosity and/or MVTR of the barrier layer
27 may be selected to prevent fluid contact of the pH
28 indicating agent by such moisture.

29 The indicating layer 74 includes a pH indicating
30 agent that may be arranged to provide a graphic design or
31 message. Also, the Ph indicating agent may be
32 translucent or substantially not visible through the
33 backing sheet 82 prior to fluid contact. Accordingly,

1 the fluid contact activates the pH indicating agent to
2 provide a graphic message.

3 Of course, the diaper 80 may comprise any urinary
4 incontinence article, sanitary napkin, a bandage or a
5 like article. In addition to such personal wear
6 articles, the wetness indicators may be used in an
7 environment to be monitored for moisture. For example,
8 the wetness indicator may be secured to a viewing window
9 of a home clothes dryer.

10 One or more composite layers may be formed from
11 curing pH indicating inks. The layers may be in the form
12 of films or discontinuous dots dependent on the graphic
13 desired. Inks can be compounded with carriers that are
14 solvents or water where cure occurs in general by drying
15 off the carrier. Inks can also be compounded to be
16 substantially solvent or water free and cured by exposure
17 to UV light or other appropriate radiation sources. UV
18 inks and solvent inks are preferred embodiments. Water
19 based inks tend to have some residual moisture after
20 drying and the resin components tend to have a pH value
21 which is imparted to the ink composition both of which
22 may render portions prematurely activated. UV and
23 solvent inks do not have a pH.

24 The following ink formulations are illustrative of
25 useful inks in accordance with the invention.

26 Formulation 1 UV Cured-without fluid regulating additive

27	Ingredient	Weight %
28	Photomer 4094 (Cognis)	28-40
29	Photomer 5429 "	28-40
30	Photomer 4967 "	8-13
31	Texaphor 3241 "	1-5
32	Photomer 51 "	1-5
33	Irgacure 369 (Ciba)	1-4
34	Bromo Cresol Green	0.5-12

1 Formulation 2 UV Cured-with fluid regulating additive

2	Ingredient	Weight %
3	Photomer 4094 (Cognis)	28-40
4	Photomer 5429 "	28-40
5	Photomer 4967 "	8-13
6	Texaphor 3241 "	1-5
7	Photomer 51 "	1-5
8	Irgacure 369 (Ciba)	1-4
9	Bromo Cresol Green	3-8
10	ETHOCEL (Dow)	0.5-8

11 Formulation 3 Solvent based-without fluid regulating
12 additive

13	Ingredient	Weight %
14	Vinavil K40 (Cognis)	15-30
15	Dow Corning Z 6011	1-5
16	Rewopol SBD075	0.2-08
17	N Propyl alcohol	40-55
18	Ethyl acetate	10-20
19	Bromo Cresol Green	0.5-12

20 Formulation 4 Solvent based-with fluid regulating
21 additive

22	Ingredient	Weight %
23	Vinavil K40 (Cognis)	15-30
24	Dow Corning Z 6011	1-5
25	Rewopol SBD075	0.2-0.8
26	N Propyl alcohol	40-55
27	Ethyl acetate	10-20
28	Bromo Cresol Green	3-8
29	ETHOCEL (Dow)	0.5-8

30 The foregoing formulations may be modified at specific
31 components and composition percentages, and they are
32 merely provided as being illustrative of useful pH
33 indicating ink compositions.

34 The resins used to provide a body or a binder for
35 the matrix in the inks include polymers of acrylates,
36 alkyd resins, amides, amino resins, ethylene co-
37 terpolymer resins such as EVA, epoxy resins,
38 fluoropolymers, hydrocarbon resins, phenols, polyesters,

1 olefins, polyurethanes, silicone, polystyrene and
2 polyvinyls.

3 While particular embodiments of the present
4 invention had been illustrated and described, it would be
5 obvious to those skilled in the art and various other
6 changes and modifications can be made without departing
7 from the spirit and scope of the invention. It is
8 intended to cover in the appended claims all such changes
9 modifications that are within scope of this invention.